ORBITAL/SUB-ORBITAL PROGRAM 2 (OSP2)

ATTACHMENT 2.A

TECHNICAL REQUIREMENTS DOCUMENT

MINUTEMAN-CLASS

TARGET LAUNCH VEHICLE CONFIGURATION

(MMTLV)

DRAFT 1

29 August 2001

RFP XXXXXXX

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1.0 SCOPE

1.1 Objective

The Government's objective is to utilize excess Minuteman (MM) assets to provide a launch capability to deliver single or multiple payloads on ICBM trajectories. To support this objective, assembled Minuteman II boosters consisting of the standard MMII motors and interstages will be made available as GFP. Other motors may be used at the Contractor's discretion. Primary use of the MMTLV is expected to be to provide targets for ballistic missile defense systems testing. However, any test program requiring a Minuteman-class ballistic missile launch may be supported.

1.2 Overview

This document defines performance requirements for a launch system capable of placing a variety of payloads on typical ICBM trajectories. The payload and associated AVE will be mated to the Launch Vehicle payload interface. Three launch vehicle configurations may be required to meet the variations in payload requirements. These are summarized below:

A) Baseline Unshrouded, Multiple Payload Configuration: This configuration supports payloads consisting of multiple targets including a Reentry Vehicle (RV). Targets other than the RV will be packaged in a Payload Rack which will also contain payload electronics. The RV will be flown unshrouded for most of the trajectory thus requiring a fairing on the launch vehicle to provide a smooth aerodynamic interface with the aft end of the RV. The typical mission requires extensive maneuvers after thrust termination of the final propulsive stage to deploy multiple payloads in specified directions. A temporary shroud will typically be required during the launch to protect the RV against the plume as the missile exits the silo. This shroud will be jettisoned after the vehicle exits the plume. Additional requirements are included in Section 3.2.1.1.

B) Shrouded, Multiple Payload Configuration: This configuration requires a shroud to provide protection to the payload, which consists of multiple targets including a Reentry Vehicle or simulator. Provisions in the launch vehicle will also be made to install a Payload Rack, which will contain payload electronics and the other deployable targets. The typical mission requires extensive maneuvers after thrust termination of the final propulsive stage to deploy the multiple payloads in specified directions. Additional requirements are included in Section 3.2.1.2.

C) Heavy Lift Configuration: This configuration supports payloads weighing up to 1200 lbs and consisting of either multiple targets, similar to

Configuration A, or a single RV in an unshrouded configuration. This configuration will also require a fairing on the launch vehicle to provide a smooth aerodynamic interface with the aft end of the RV. A temporary shroud to protect the RV from plume effects during launch may also be required. If a single RV is flown, all nonessential parts of the (A) configuration shall be removed to maximize throw-weight, and the typical mission will consist of a single pitch over maneuver after thrust termination to deploy the RV at the proper attitude. Additional requirements are included in Section 3.2.1.3.

Performance requirements for several "enhanced capability" options are defined in Appendix A to provide additional capabilities. These correlate to CLINs identified in Section ___. The Launch Vehicle shall meet these requirements for those missions on which the applicable CLIN is exercised.

Additional payload definition and detailed mission requirements will be provided in a Mission Requirements Document (MRD) issued by the Government at the time authorization to proceed is given for each mission.

2.0 APPLICABLE DOCUMENTS

2.1 Compliance Documents

The documents listed below shall be complied with to the extent specified in the column entitled "Tailored Application":

Number/Date	Title	Tailored Application
2.1.1 ER/WR 127- 1 31 Oct 1997 Change Pages 23 Oct 2000	Eastern and Western Range, Range Safety Requirements	As Tailored with Range Safety approval
2.1.2 IRIG Standard 106-96	Telemetry Standards	

3.0 REQUIREMENTS

3.1 System Description

The OSP-2 MM based Target Launch System consists of the Launch Vehicle (LV) and Ground Segment.

3.1.1 Launch Vehicle

The Government will provide Minuteman II motors, interstages, and associated equipment as GFP. The motors and interstages will be assembled into a multi-stage booster, certified for flight, and be delivered to the launch site by the Government.

The Contractor shall provide hardware and software to accomplish the following functions:

- Payload interface
- Guidance and control
- Instrumentation and telemetered data
- Airborne range safety functions
- Attitude control after final stage burn out.
- Additional propulsion capability as required

3.1.2 Ground Segment

The ground segment consists of:

- Contractor furnished Support Equipment consisting of all equipment required to process, integrate, check-out, and launch the LV. Three sets of equipment shall be required to support simultaneous operations of factory development and field processing of two vehicles.

- Minuteman ground support equipment and handling equipment provided GFP as available.

- Launch Facilities furnished by the Government. Modifications if necessary shall be furnished by the Contractor.

3.2 Characteristics

3.2.1 Payload Configurations

The Launch Vehicle shall be designed to accommodate a variety of payload sizes, shapes and interfaces. The Contractor shall develop a standard payload interface, addressing both electrical and mechanical interface requirements, and which meets the requirements specified herein. Once an acceptable interface is established, the Contractor shall support all future payload configurations that comply with the standard interface. Payloads may vary in quantity, weights, structural characteristics, electrical interfaces, and deployment requirements, but the physical interfaces (wires, connectors, bolt patterns) will not be changed.

3.2.1.1 Configuration (A)

The Launch Vehicle shall be designed to interface with an unshrouded RV. The LV, if silo launched, shall include a temporary shroud to provide thermal protection to the RV and protect it against the plume environment. The LV shall also provide a fairing to provide a smooth aerodynamic interface between the front end of the LV and the aft end of the RV. It shall also provide a mounting location and provide aerothermal protection during ascent for the payload rack defined in Figure 3-1; it shall also allow for deployment of targets from the rack after thrust termination.

The payload, as furnished by an associate contractor will typically consist of:

(1) A payload rack, which provides three mechanical interfaces to the LV. The three interfaces are the Front Section (FS) connector brackets, the payload rack to the FS payload plate, and the fairing to the payload support ring.

(2) A Reentry Vehicle (RV) and its ejection system mounted on the payload rack.

(3) Up to eight canisterized payloads with their ejection systems packaged in launch tubes mounted in the payload rack.

(4) Payload support components, which are also packaged in the rack.

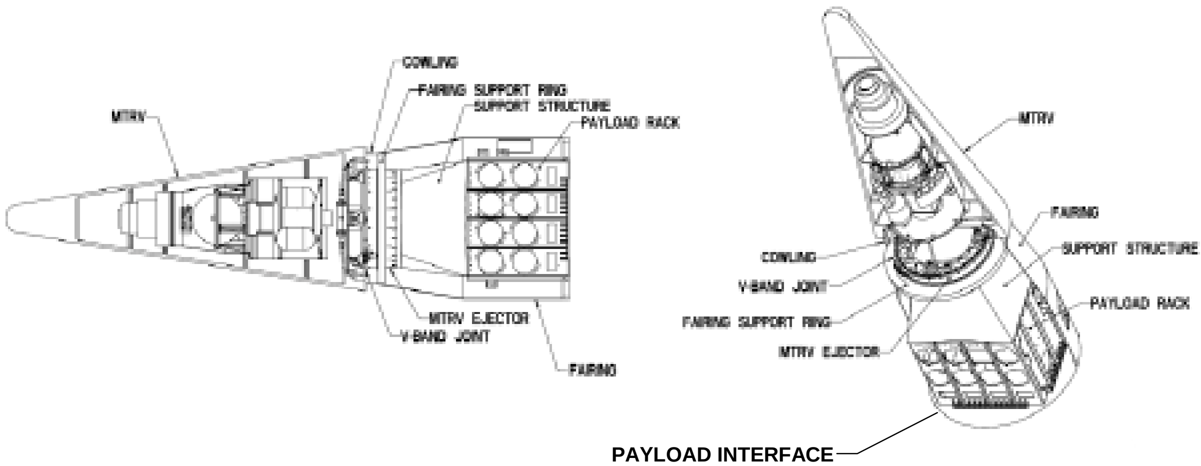


Figure 3-1. Configuration (A)

The sample mission defined in Appendix B shall be used to define the capabilities required of the LV. Where requirements elsewhere in this TRD exceed those defined in Appendix B, the TRD shall take precedence.

The actual payload configurations and targeting requirements for any given mission may vary substantially but will be within the capabilities of a LV configuration that meets the requirements defined in this document.

3.2.1.1.1 Mechanical

3.2.1.1.1.1 Envelope

The LV payload fairing shall provide sufficient clearance for the Payload Rack as defined in Figure 3-2. Note that both ends of the launch tubes must be clear of any interference to allow for target deployments. Minor localized incursions beyond the boundaries of the defined envelope by the launch vehicle or payload may be allowed on a mission-specific basis. These deviations shall be documented and controlled in the Payload-to-Launch Vehicle ICD.

3.2.1.1.1.2 Access

The Launch System shall provide access to the payload rack after the fairing and temporary shroud are mated without breaking electrical connections. The minimum opening size shall be 100 square inches. Access size and location shall be defined in the ICD.

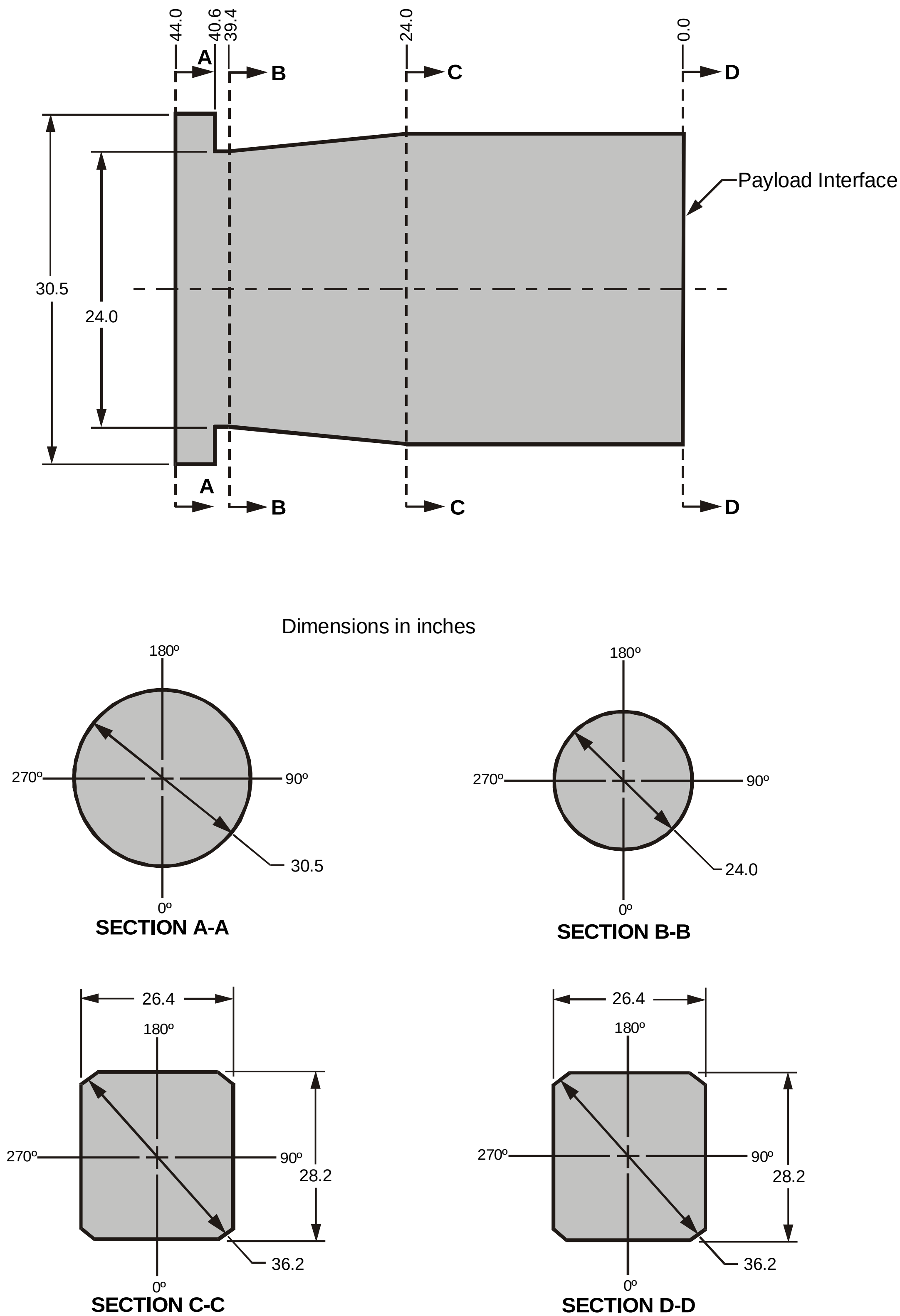


Figure 3-2. Configuration (A) Payload Envelope

3.2.1.1.1.3 Interface

The LV shall provide a standard non-separating structural interface on which to mount the Payload Rack. The interface to the RV will be a V-band connecting to the base of the RV. The fairing shall interface with the payload cowling and fairing support ring (Figure 3-1) to minimize any adverse aerodynamic heating or drag effects. Note that the dimensions of the RV heatshield are classified. The dimensions of the V-band interface are unclassified.

3.2.1.1.1.4 Mass Properties

The LV shall accommodate a total payload mass up to 1000 lbs with a lateral center of gravity offset up to 1 inch. The LV shall provide the capability of accommodating any payload weight up to its maximum capability.

3.2.1.1.1.5 Structural Characteristics

The LV shall accommodate payloads with a first mode cantilevered natural frequency greater than 13 Hz.

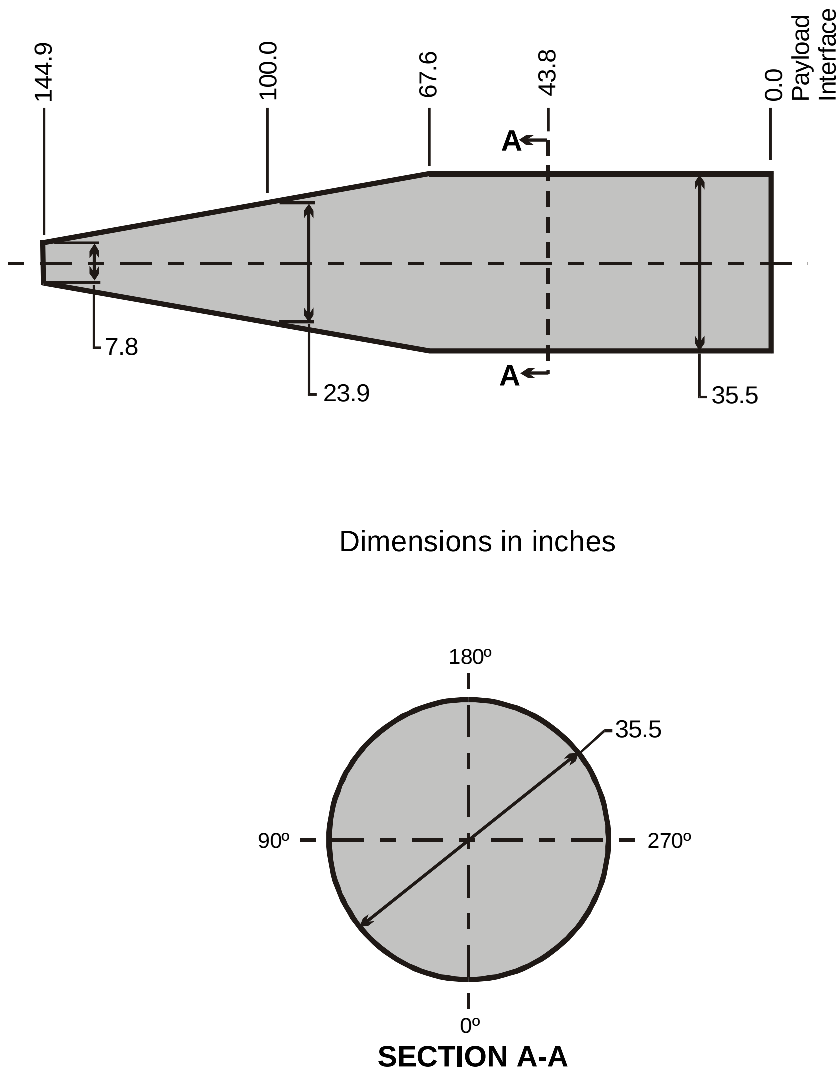
3.2.1.1.1.6 Payload Fairing Deployment

In order to minimize impact on throw-weight while providing sufficient aerothermal protection to the front end of the launch vehicle and minimizing drag losses, the payload fairing shall be deployed as soon as feasible at an altitude greater than 300K ft.

3.2.1.1.1.7 Early Release Shroud

The LV, if silo launched, shall include a temporary shroud to provide thermal protection to the RV and protect it against the plume environment during launch. The temporary shroud shall be deployed as early as possible to minimize any loss in throw-weight and to ensure the components impact near the launch facility. It shall not be deployed before the RV exits the plume from the launch environment. The deployment system shall be designed to prevent any pieces from impacting the missile. No additional wind restrictions shall be imposed due to the use of the temporary shroud.

The LV temporary shroud shall provide a minimum payload envelope as defined in Figure 3-3. Minor localized incursions beyond the boundaries of the defined envelope by the launch vehicle or payload may be allowed on a mission-specific basis. These deviations shall be documented and controlled in the Payload-to-Launch Vehicle ICD. The temporary shroud shall be RF transparent or provide RF transparent windows to allow the RV to have direct RF communication with telemetry ground stations and GPS during pre-launch operations. The size and location of these windows shall be defined in the Payload-to-Launch Vehicle ICD.



SECTION A-A

Figure 3-3. Early Release Shroud Payload Envelope

3.2.1.1.2 Electrical Interfaces

3.2.1.1.2.1 Command, Control, and Monitor

The Launch System shall provide umbilicals and cabling to allow the Payload Support Equipment to provide power and communicate with the payload until launch. Up to 128 lines (copper paths) shall be provided.

3.2.1.1.2.2 Payload to Front Section Communication

Communications between the Front Section and the payload shall be made through redundant standard serial UART protocols using RS422 drivers. All commands from the FS to the payload shall be issued three times in succession using hexadecimal format thus allowing up to 256 different commands.

3.2.1.1.2.3 Verification

The FS shall verify receipt of commands sent to the payload. The payload will provide a direct return circuit for command signals back to the FS to verify receipt of the commands.

3.2.1.1.2.4 Ordnance

There is no requirement for the FS to provide safing of payload ordnance. Safing of all payload ordnance will be accomplished on the payload side of the interface.

3.2.1.1.2.5 GPS Timing Signal

The front section shall provide a GPS based one pulse per second timing signal to the payload with a minimum active high pulse width of .02 millisec. This signal shall be optically isolated at the payload and shall be capable of driving a 5 Vdc, 1 mA load. The payload will include in its telemetry stream a counter value corresponding to time since the last timing pulse from the front section.

3.2.1.1.2.6 Antenna Utilization

The Launch Vehicle (LV) shall provide a re-radiation system to facilitate the transmission of Payload RF links. The signals may include upper and lower S-band and lower C-band or some portion thereof. The temporary shroud (Section 3.2.1.1.1.7) shall be either RF transparent or contain RF transparent windows to allow Payload communications during pre-launch and before shroud removal.

Additionally, the LV shall provide a system to permit transmission of Payload telemetry through LV antennas. The payload will provide the telemetry through hard lines to the LV interface. The LV shall provide hardware for combining the signals and coupling them to the LV antennas. Telemetry transmission may be required throughout flight including pre-launch. The specific requirements will be mission dependent and shall be documented in the Payload-to-Launch Vehicle ICD.

The LV shall also be able to provide GPS (L-band) signals to the payload through a RF transparent shroud or RF transparent windows in the temporary shroud, as defined in Section 3.2.1.1.1.7, during pre-launch and before shroud removal. Additionally, the LV shall provide hard-lines to the payload interface from the LV GPS antennas for pre-launch checkout of payload under the fairing. The specific requirements will be mission dependent and shall be documented in the Payload-to-Launch Vehicle ICD.

3.2.1.2 Configuration (B)

The Launch Vehicle shall be designed to accommodate a variety of payload sizes, shapes and interfaces. The payload, as furnished by an associate contractor will typically consist of:

(1) A payload rack, which provides a single mechanical interface to the LV.

(2) A Reentry Vehicle (RV) or Heavy Object (HO) and its ejection system mounted on top of the payload rack.

(3) Up to two Rigid Light Replicas (RLR), which are essentially hollow cones, packaged on top of the RV.

(4) Up to eight canisterized payloads with their ejection systems packaged in launch tubes mounted in the payload rack.

(5) Payload support components, which are also packaged in the rack.

The actual payload configurations and targeting requirements for any given mission may vary substantially but will be within the capabilities of a LV configuration that meets the requirements defined in this document.

3.2.1.2.1 Mechanical

3.2.1.2.1.1 Envelope

The LV shall provide a minimum payload envelope as defined in Figure 3-4. Minor localized incursions beyond the boundaries of the defined envelope by the launch vehicle or payload may be allowed on a mission-specific basis. These deviations shall be documented and controlled in the Payload-to-Launch Vehicle ICD. (See Appendix A C-1 for the Increased Payload Volume Enhanced Capability option.)

3.2.1.2.1.2 Access

The Launch System shall provide access to the payload after shroud mate without removing the shroud or breaking electrical connections. The minimum opening size shall be 100 square inches. Access size and location shall be defined in the ICD.

3.2.1.2.1.3 Interface

The LV shall provide a standard nonseparating structural interface on which to mount the payload assembly.

3.2.1.2.1.4 Mass Properties

The LV shall accommodate a total payload mass up to 1000 lbs with a lateral center of gravity offset up to 1 inch. The LV shall provide the capability of accommodating any payload weight up to its maximum capability.

3.2.1.2.1.5 Structural Characteristics

The LV shall accommodate payloads with a first mode cantilevered natural frequency greater than 13 Hz.

3.2.1.2.1.6 Thermal

The Launch System shall provide aerothermal protection to the payload prior to launch and during ascent. The internal wall temperature of the shroud shall be limited to 200 deg F in the cylindrical portion during ascent. The shroud shall be retained until at least 300 Kft altitude. During ground processing prior to launch, the payload temperature shall be maintained within 60 to 100 deg F neglecting internal heating sources from the payload.

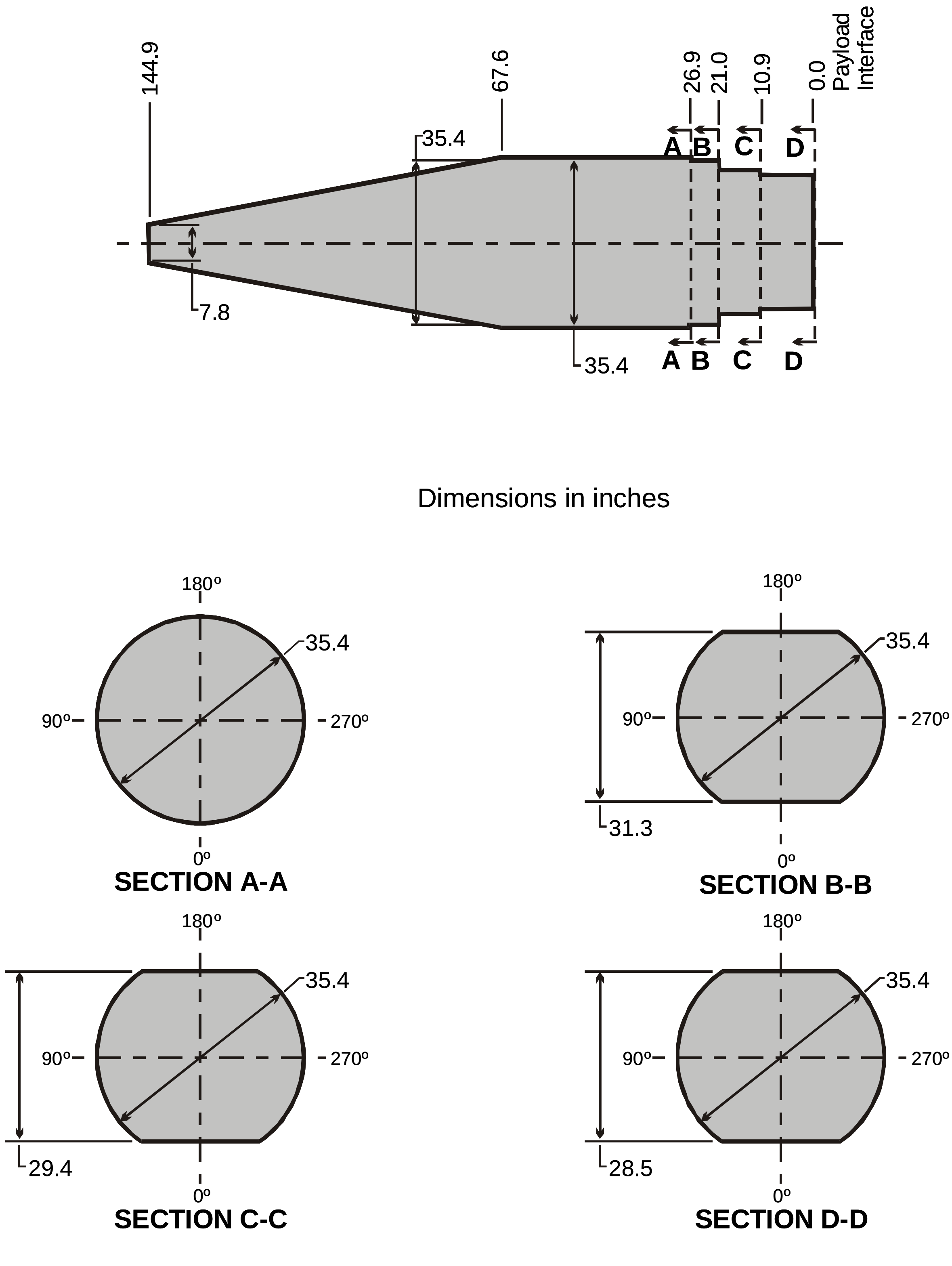


Figure 3-4. Configuration (B) Payload Envelope

3.2.1.2.2 Electrical Interfaces

3.2.1.2.2.1 Command, Control, and Monitor

The Launch System shall provide umbilicals and cabling to allow the Payload Support Equipment to provide power and communicate with the payload until launch. Up to 128 lines (copper paths) to the payload shall be provided.

3.2.1.2.2.2 Payload to Front Section Communication

Communications between the Front Section and the payload shall be made through redundant standard serial UART protocols using RS422 drivers. All commands from the FS to the payload shall be issued three times in succession using hexadecimal format thus allowing up to 256 different commands.

3.2.1.2.2.3 Verification

The FS shall verify receipt of commands sent to the payload. The payload will provide a direct return circuit for command signals back to the FS to verify receipt of the commands.

3.2.1.2.2.4 Ordnance

There is no requirement for the FS to provide safing of payload ordnance. Safing of all payload ordnance will be accomplished on the payload side of the interface.

3.2.1.2.2.5 GPS Timing Signal

The front section shall provide a GPS based one pulse per second timing signal to the payload with a minimum active high pulse width of .02 millisec. This signal shall be optically isolated at the payload and shall be capable of driving a 5 Vdc, 1 mA load. The payload will include in its telemetry stream a counter value corresponding to time since the last timing pulse from the front section.

3.2.1.2.2.6 Antenna Utilization

The Launch Vehicle (LV) shall provide a re-radiation system to permit transmission of Payload RF links through LV antennas. This shall include upper and lower S-band, and C-band. The payload will provide the signals through hard-lines to the LV interface. The LV shall provide hardware for combining the signals and coupling them to the LV antennas. S-band links are required throughout flight. The requirement for the upper

S-band and C-band links is to provide the capability in the pre-launch configuration with a goal to continue to provide it through flight until shroud removal. The specific requirements will be mission dependent and shall be documented in the Payload-to-Launch Vehicle ICD.

The LV shall also provide GPS (L-band) signals to the payload, until shroud removal, using the LV GPS antennas and hard wiring the signals to the payload interface.

3.2.1.3 Configuration (C)

The Launch Vehicle shall be designed to interface with an unshrouded RV. The LV, if silo launched, shall include a temporary shroud to provide thermal protection to the RV and protect it against the plume environment. The LV shall also provide a fairing to provide a smooth aerodynamic interface between the front end of the LV and the aft end of the RV. If multiple payloads are included, it shall also provide a mounting location and provide aerothermal protection during ascent for the payload rack. It shall also allow for deployment of targets from the rack after thrust termination.

The actual payload configurations and targeting requirements for any given mission may vary substantially but will be within the capabilities of a LV configuration that meets the requirements defined in this document.

3.2.1.3.1 Mechanical

3.2.1.3.1.1 Envelope

The LV payload fairing shall provide sufficient clearance for the Payload Structure. Detailed envelope and localized incursions shall be documented and controlled in the Payload-to-Launch Vehicle ICD.

3.2.1.3.1.2 Access

The Launch System shall provide access to the payload after the fairing and temporary shroud are mated without breaking electrical connections. The minimum opening size shall be 100 square inches. Access size and location shall be defined in the ICD.

3.2.1.3.1.3 Interface

The LV shall provide a standard non-separating structural interface on which to mount the Payload Structure. The interface to the RV will be a V-band connecting to the base of the RV. The fairing shall interface with the payload cowling and fairing support ring to minimize any adverse aerodynamic heating or drag effects. Note that the dimensions of the RV heatshield are classified. The dimensions of the V-band interface are unclassified

3.2.1.3.1.4 Mass Properties

The LV shall accommodate a total payload mass up to 1200 lbs with a lateral center of gravity offset up to 1 inch. The LV shall provide the capability of accommodating any payload weight up to its maximum capability.

3.2.1.3.1.5 Structural Characteristics

The LV shall accommodate payloads with a first mode cantilevered natural frequency greater than 13 Hz.

3.2.1.3.1.6 Payload Fairing Deployment

If necessary to minimize impact on throw-weight while providing sufficient aerothermal protection to the front end of the launch vehicle and minimizing drag losses, the payload fairing shall be deployed as soon as feasible at an altitude greater than 300K ft.

3.2.1.3.1.7 Early Release Shroud

The LV, if silo launched, shall include a temporary shroud to provide thermal protection to the RV and protect it against the plume environment during launch. The temporary shroud shall be deployed as early as possible to minimize any loss in throw-weight and to ensure the components impact near the launch facility. It shall not be deployed before the RV exits the plume from the launch environment. The deployment system shall be designed to prevent any pieces from impacting the missile. No additional wind restrictions shall be imposed due to the use of the temporary shroud.

The LV temporary shroud shall provide a minimum payload envelope as defined in Figure 3-3. Minor localized incursions beyond the boundaries of the defined envelope by the launch vehicle or payload may be allowed on a mission-specific basis. These deviations shall be documented and controlled in the Payload-to-Launch Vehicle ICD. The temporary shroud shall be RF transparent or provide RF transparent windows to allow the RV to have direct RF communication with telemetry ground stations and GPS during pre-launch operations. The size and location of these windows shall be defined in the Payload-to-Launch Vehicle ICD.

3.2.1.3.2 Electrical Interfaces

3.2.1.3.2.1 Command, Control, and Monitor

The Launch System shall provide umbilicals and cabling to allow the Payload Support Equipment to provide power and communicate with the payload until launch. Up to 128 lines (copper paths) shall be provided.

3.2.1.3.2.2 Serial Communication

Communications between the Front Section and the payload shall be made through redundant standard serial UART protocols using RS422 drivers. Commands from the FS to the payload shall be issued three times in succession using hexadecimal format thus allowing up to 256 different commands.

3.2.1.3.2.3 Electrical Discretes

The LV shall provide the following circuits based on 1.5 ohm payload loads:

Quantity:	4 circuits
Minimum current:	5 amp
Timing accuracy:	10 millisec
Minimum Duration:	35 millisec
Simultaneity:	Individually or up to 4 discretes with a tolerance of 1 millisec
Safing	Provide safing in accordance with Paragraph 2.1.1

The circuits shall also be capable of providing 28 volts $\pm$ 4 volts to a high resistance load.

3.2.1.3.2.4 Verification

The FS shall verify receipt of commands sent to the payload. The payload will provide a direct return circuit for command signals back to the FS to verify receipt of the commands.

3.2.1.3.2.5 GPS Timing Signal

The front section shall provide a GPS based one pulse per second timing signal to the payload with a minimum active high pulse width of .02 millisec. This signal shall be optically isolated at the payload and shall be capable of driving a 5 Vdc, 1 mA load. The payload will include in its telemetry stream a counter value corresponding to time since the last timing pulse from the front section.

3.2.1.3.2.6 Antenna Utilization

The Launch Vehicle (LV) shall provide a re-radiation system to facilitate the transmission of Payload RF links. The signals may include upper and lower S-band and lower C-band or some portion thereof. The temporary shroud (Section 3.2.1.3.1.7) shall be either RF transparent or contain RF transparent windows to allow Payload communications during pre-launch and before shroud removal.

Additionally, the LV shall provide a system to permit transmission of Payload telemetry through LV antennas. The payload will provide the telemetry through hard-lines to the LV interface. The LV shall provide hardware for combining the signals and coupling them to the LV antennas. Telemetry transmission may be required throughout flight including pre-launch. The specific requirements will be mission dependent and shall be documented in the Payload-to-Launch Vehicle ICD.

The LV shall also be able to provide GPS (L-band) signals to the payload through a RF transparent shroud or RF transparent windows in the temporary shroud, as defined in Section 3.2.1.1.1.7, during pre-launch and before shroud removal. Additionally, the LV shall provide hard-lines to the payload interface from the LV GPS antennas for pre-launch checkout of payload under the fairing. The level shall be at least -128 dBm minimum. The specific requirements will be mission dependent and shall be documented in the Payload-to-Launch Vehicle ICD.

3.2.2 Payload Environments

3.2.2.1 Shock

The LV shall ensure shocks induced at the payload interface from all LV sources do not exceed the following Maximum Predicted Environment (MPE):

MPE Level

Frequency (Hz)	**SRS** (g's Peak)
20	13
200	100
800	733

1500	2250
10000	2250

3.2.2.2 Dynamic Environments

The following environments shall be determined by the Contractor and defined in the ICD for the applicable mission.

- Vibration
- Transient loads
- Steady state acceleration

3.2.2.3 Environmental Control

3.2.2.3.1 Contamination

Provisions shall be made to facilitate the implementation of a continuous clean dry nitrogen purge if required. (See Appendix A for enhanced capability option).

3.2.2.4 Plume Effects

The LV shall minimize plume effects from all propulsion sources in terms of forces applied to the payloads after deployment and contamination prior to and after deployment. Specific requirements, such as ΔV or tip-off, will be defined in the MRD.

3.2.3 Performance

3.2.3.1 Payload Capability

The launch vehicle shall be capable of delivering the following payload masses on the reference trajectory defined in Appendix B

Configuration A: 850 lbs
Configuration B: 870 lbs
Configuration C: 1050 lbs

Sufficient performance margins shall be included to provide a 100 lbm propellant residual for nominal trajectory performance conditions.

3.2.3.2 Flight Path Angles

The launch vehicle shall be capable of trajectories resulting in reentry flight path angles from 20 degrees to 40 degrees for other payload weights and ranges.

3.2.3.3 Accuracy

For the reference trajectory specified in Appendix B, the primary Reentry Vehicle shall pass through a 3 nmi circle lying in the horizontal plane at the target point with a 99% probability. In determining accuracy, errors due to the payload ejection system in velocity magnitude and direction will not be included.

3.2.3.4 Timing

The time from lift-off to arrival of the primary Reentry vehicle at the target altitude shall be controlled within $\pm$ 1.5 seconds, 3-sigma.

3.2.3.5 Final Propulsion Stage Separation

After thrust termination or burnout, the front section (FS) shall separate from the final propulsion stage. A selectable velocity up to 30 ft/sec nominal (23 ft/sec, 3-sigma worst case) shall be applied to the stage relative to the FS at separation. The velocity vector shall be controlled within 10 degrees of the nominal direction as defined in the MRD. (See Appendix A for enhanced capability option).

3.2.3.6 Deployment Sequence

3.2.3.6.1 Configuration (A)

The Launch Vehicle shall accommodate any deployment sequence within the capability of the Baseline design required to meet the deployment sequence defined in Appendix B.

3.2.3.6.2 Configuration (B)

The Launch Vehicle shall accommodate any deployment sequence within the capability of the Baseline design required to meet the deployment sequence defined in Appendix B.

3.2.3.6.3 Configuration (C)

The Launch Vehicle shall accommodate any deployment sequence within the capability of the Baseline design required to meet the deployment sequence defined in Appendix B, or be capable of performing a pitch maneuver up to 150 deg prior to deploying the RV.

3.2.3.7 Attitude Control

3.2.3.7.1 Attitude Accuracy

The Attitude Control System (ACS) shall control attitude of the FS within 1 deg 3-sigma, with rates less than 1-deg/sec 3-sigma. Rates induced due to payload deployments shall be minimized.

3.2.3.7.2 Spin Reaction: Configuration (B) Only

The FS shall be capable of reacting forces created by a spinning payload, in which the payload assembly is spun up to 6 radians/sec within 5 sec and maintained. The ACS shall be designed such that it is not adversely affected by the angular momentum.

3.2.4 Telemetry and Instrumentation

The Launch System shall collect and transmit sufficient data during prelaunch and in-flight to assess status, performance, and environments; to meet all Range Safety requirements per Paragraph 2.1.1; and to provide diagnostics in the event of anomalous performance.

3.2.4.1 Navigation Data

The LV shall provide navigation data with an accuracy of approximately 25 m (1-sigma) at 1 Hz intervals.

3.2.4.2 Telemetry Characteristics

The LV shall provide pulse code modulation (PCM) telemetry in accordance with Paragraph 2.1.2. It shall provide a total bit rate of at least 750 Kbps. The telemetry system shall provide flexibility in allocating channel bandwidths. The capability shall be provided to preprogram a time at which telemetry transmission is terminated.

3.2.4.3 Transmitter and Antenna Characteristics

Signal-to-noise margins over 95% of the radiation sphere shall be adequate to achieve a bit error rate no greater than 10^{-6} when transmitting 2100 nmi to a ground station antenna with a gain (G/T) of 15 dB/^{o}K.

3.2.5 Airborne Range Safety Requirements

The Launch System shall include a command destruct system, radar aiding transponder, GPS range safety tracking, and any hardware and/or modifications required for compliance with the applicable portions of Paragraph 2.1.1. Minuteman downstage instrumentation and ordnance will be provided and installed as GFP if desired by the Contractor.

3.2.6 EMI/EMC

3.2.6.1 Emissions

The Launch System shall minimize radiated and conducted emissions that could affect the payload. Specific levels shall be documented in the Payload-to-Launch Vehicle ICD.

3.2.6.2 Susceptibility

The Launch System shall be capable of operating at any of the identified launch sites without adverse effects from the electromagnetic environments. The LV shall also be capable of withstanding EMI radiated and conducted emissions from the payloads. Specific limitations imposed on the payloads shall be documented in the Payload-to-Launch Vehicle ICD.

3.2.7 Launch Availability

The vehicle shall be capable of launching under 90 percentile (annual) wind conditions from VAFB. All other limitations (excluding weather) shall not preclude launching for more than one hour per 24 hour period.

3.2.8 Mission Reliability

The Launch System shall have a design reliability (excluding GFP motors and interstages) of meeting all mission requirements greater than 98 percent. Equipment associated with Range Safety shall meet reliability requirements of Paragraph 2.1.1.

4.0 QUALITY ASSURANCE

4.1 Verification

A verification program shall be conducted to ensure compliance with Section 3 of this document and with the specifications developed by the Contractor. Verification shall be demonstrated through test, analysis, similarity, demonstration, or inspection.

4.2 Development Tests

A development test program shall be conducted to determine flight environments, reduce risks associated with qualifying components to new environments, quantify structural characteristics, demonstrate structural capabilities and mechanical assemblies, and assess interface compatibility among subsystems. The test program shall be structured to account for previously demonstrated flight proven capabilities.

4.3 Qualification Tests

Components shall be qualified (through test or similarity) to show adequate design margins exist over Maximum Predicted Flight (MPF) environments. Dedicated (non-flight) components shall be used for qualification testing in the case of nondevelopmental items unless waived by the Government. Software shall be subjected to a qualification test program to demonstrate compliance with requirements and robustness in off-nominal situations.

4.4 System Integration Test

A system integration test shall be performed with a goal of demonstrating all procedures, verifying SE, LV, booster, payload, and facility interfaces. The nature of the test in terms of flight hardware versus test hardware, location, and functions exercised shall be determined by the Contractor consistent with previously demonstrated performance.

4.4 Flight Proof Tests

Flight proof testing shall be conducted for each mission on flight hardware to demonstrate adequate workmanship. Component and system level testing shall be performed.

4.5 Integration Testing

Integration testing shall be performed with each payload to verify interfaces, demonstrate compatibility, and ensure compliance with the Interface Control Drawing (ICD).

5.0 NOTES

5.1 Verification (Paragraph 4.1)

5.1.1 Analysis

Verification by analysis is a process utilizing techniques and tools such as engineering analysis, statistics, computer and hardware simulations, analog modeling, validation of records, etc to verify requirements have been satisfied. It may be used in lieu of or in addition to testing when:

- Rigorous and accurate analysis is possible
- It is more cost effective than test
- Similarity is not applicable
- Inspection is not adequate

5.1.2 Similarity

Verification by similarity is permitted if it can be demonstrated that the article is sufficiently similar or identical in design to hardware which has been qualified to equivalent or more stringent environmental criteria.

5.1.3 Inspection

Verification by inspection may be used when visual examination of the hardware for compliance with workmanship, quality, and dimensional tolerance is sufficient. It may also include review of manufacturing records.

5.1.4 Demonstration

Verification by demonstration may be used when the qualitative determination of an article's properties can be made by observation under actual or simulated use conditions without special equipment or instrumentation.

5.1.5 Test

When an adequate level of confidence cannot be established by other methods of verification, testing shall be used. Testing employs technical means of measuring performance parameters relative to functional, electrical, mechanical, and environmental requirements.

APPENDIX A

ENHANCED CAPABILITY OPTIONS

This Appendix defines performance requirements for Enhanced capability Options to provide enhanced capabilities corresponding to CLIN ____ in Section ___.

A-1 Increased Payload Volume (Paragraph 3.2.1.2.1.1)

The Launch System shall accommodate a cylindrical envelope 40 inches in diameter and 60 inches long.

A-2 Nitrogen Purge (Paragraph 3.2.2.3.1)

The Launch System shall provide a continuous clean dry nitrogen purge to the payload inside the shroud throughout processing up until launch.

A-3 Front Section Separation Velocity (Paragraph 3.2.3.5)

The LV shall provide a separation velocity to the Front Section up to 50 ft/sec in a controlled direction ($\pm$ 10 deg) to be applied after deployments of payloads are completed.

APPENDIX B

SAMPLE MISSION

This appendix defines the reference trajectory, payload, and deployment conditions for the sample mission. These elements do not necessarily represent any single mission, but as a whole demonstrate the capability required of the LV.

B.1 Reference Trajectory

B.1.1 Launch Location

The LV shall be launched from site LF-06 at Vandenberg AFB (VAFB) on the Central Coast of California:

Latitude:	34.8830 deg N
Longitude:	120.6360 deg W
Altitude:	30.9 m

B.1.2 Point of Intercept

The LV shall be launched toward a point in the Broad Ocean Area approximately 330 nmi northeast of Meck Island, which is located in the Kwajalein Atoll. The LV shall be targeted such that the primary reentry vehicle passes through the Point of Intercept (POI) as defined below:

Geodetic Latitude:	14.9061 deg N
Longitude:	169.5189 deg E
Altitude:	230 km
Mission Time	1781.7 sec

B.2 Payload Requirements

B.2.1 Payload Configuration

The payload consists of 8 deployable objects, their ejection systems, electronics, and mounting hardware. The objects are 1 reentry vehicle (RV) and 7 decoys (Decoy 1 through Decoy 7).

The decoys will be packaged in canisters in launch tubes approximately 6 inches in diameter and 25 inches long that will be mounted in the Payload Rack. The Payload Rack will also include payload electronics. These objects are identified in Figure B-1.

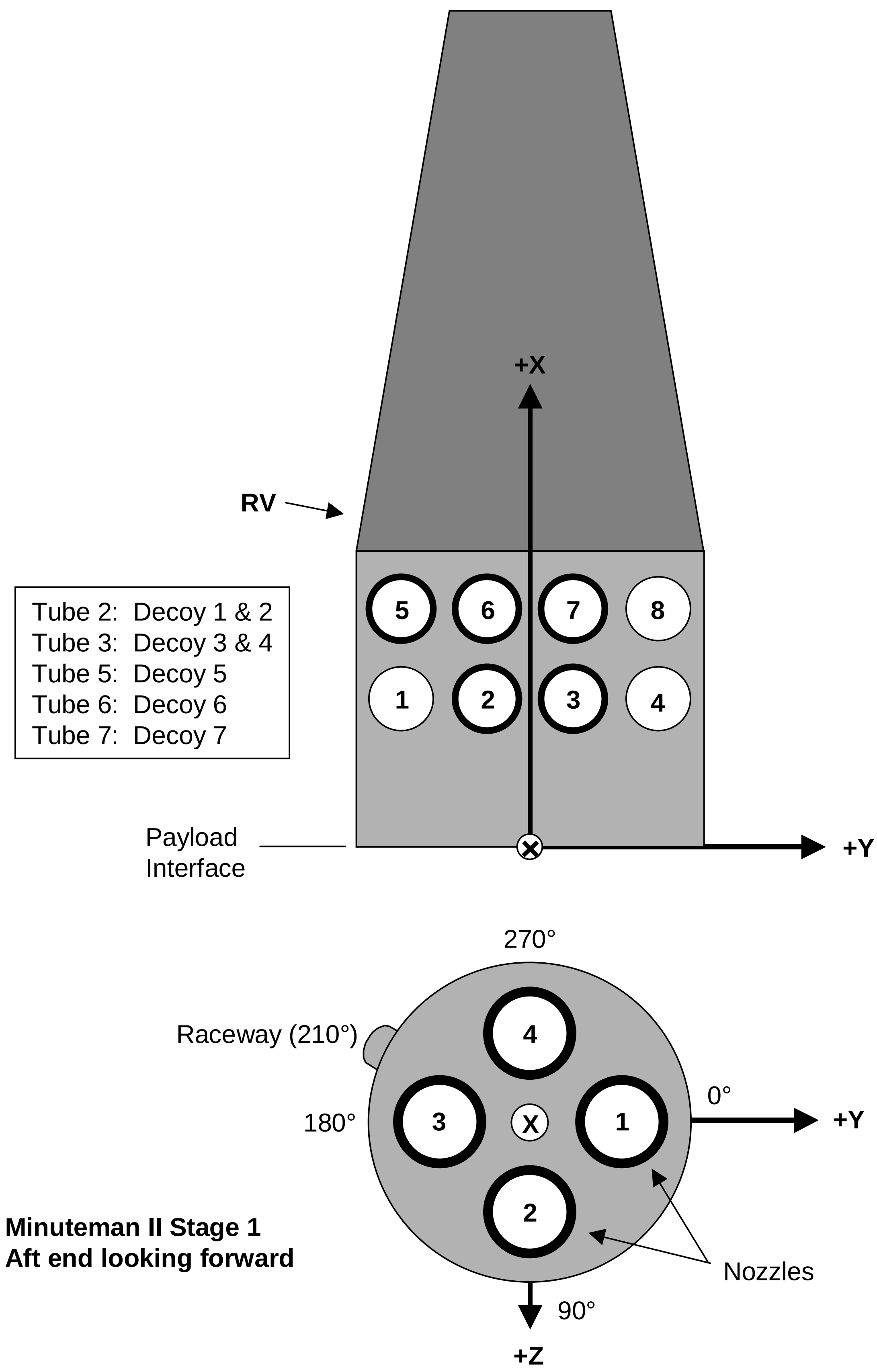


Figure B-1. Payload Mass Properties Coordinate System

B.2.2 Mass Properties

The payload mass properties are provided in Table B-1. The payload mass properties coordinate system is identified in Figure B-1.

Table B-1. Payload Mass Properties

Description	Weight (lbs)	X-C.G. (in)	Y-C.G. (in)	Z-C.G. (in)	Ixx (lb-in²)	Iyy (lb-in²)	Izz (lb-in²)
Payload Rack/ Structure	84.00	20.26	0.03	0.12	16936	20040	21795
Electronics	60.00	2.91	-2.97	3.70	4310	1106	3520
Tube-2 (Decoy 1, 2)	7.11	10.50	-3.33	6.81	308	310	32
Decoy 1	6.45	10.50	-3.33	1.19	532	532	13
Decoy 2	2.11	10.50	-3.33	-3.97	7	6	7
Tube-3 (Decoy 3, 4)	7.11	10.50	3.33	6.81	308	310	32
Decoy 3	6.45	10.50	3.33	-1.19	532	532	13
Decoy 4	2.11	10.50	3.33	3.97	7	6	7
Tube-5 (Decoy 5)	10.75	18.50	-9.99	.81	679	678	49
Decoy 5	3.58	18.50	-9.99	-6.19	72	72	5
Tube-6 (Decoy 6)	4.74	18.50	-3.33	0.00	75	17	75
Decoy 6	7.00	18.50	-3.33	-11.47	22	22	43
Tube-7 (Decoy 7)	4.74	18.50	3.33	0.00	75	72	75
Decoy 7	2.00	18.50	3.33	-11.47	7	6	7
Ejector	41.30	45.93	0.00	0.00	4390	2397	2403
RV	595.00	78.36	0.00	0.00	62,000	344,000	344,000
Cowling	2.06	46.50	0.00	0.00	326	164	164
Fairing Support Ring	8.44	44.53	0.00	0.00	1566	785	785
Misc.	15.05	26.00	0.00	0.00	2792	1400	1400
Total	**870**	**60.00**	**-0.39**	**0.24**	**100,170**	**1,065,400**	**1,066,857**

B.3 Deployment Requirements

B.3.1 Mission Sequence

The FS shall deploy the targets according to the sequence given in Table B-2.

Table B-2. Mission Sequence

Event	Mission Time (sec)	Deployment Direction ECI Unit Vector[1] (Dimensionless)			Deploy-ment Axis (Fig B-1)	Deploy - ment Vel[2] (m/sec)
		X	Y	Z		
Simulated deployment	250	-.09356680	.93300000	-.34750000	+X	*N/A*
Simulated deployment	270	-.15312660	.82000000	-.55150000	+X	N/A
Deploy RV	290	-.074162	.930000	-.360000	+X	1.5
End attitude hold	302	-.074162	.930000	-.360000		N/A
Deploy Decoy 6	350	.280000	.9180000	-.2808487	-Z	3.0
End attitude hold	362	.280000	.9180000	-.2808487		N/A
Deploy Decoy 2	377	-.16066297	.96301738	-.21629826	-Z	1.7
End attitude hold	389	-.16066297	.96301738	-.21629826		N/A
Deploy Decoy 3	404	-.21599487	.96978447	-.11342085	-Z	.91
End attitude hold	416	-.21599487	.96978447	-.11342085		N/A
Deploy Decoy 4	440	.250000	.8450000	-.4727314	+Z	2.1
End attitude hold	452	.250000	.8450000	-.4727314		N/A
Deploy Decoy 1	467	-.15598122	.91412328	-.37423053	+Z	3.0
End attitude hold	479	-.15598122	.91412328	-.37423053		N/A
Deploy Decoy 5	504	-.05393490	.86319130	-.50198785	-Z	2.0
End attitude hold	516	-.05393490	.86319130	-.50198785		N/A
Deploy Decoy 7	531	-.05393490	.86319130	-.50198785	-Z	4.00
End attitude hold	551	-.05393490	.86319130	-.50198785		N/A

Notes

1. The ECI coordinate system is based on Mission Time which is 0 when the ECI is coincident with ECEF coordinates. Therefore the launch vehicle captures the ECEF coordinate at T=0. The Z axis is out of the North Pole. The X axis is out of the Greenwich Meridian at the point it crosses the equator. The Y axis completes the right hand triad. The earth center is established by the World Geodetic Survey 1984 model.
2. All deployment velocities are incremental velocity applied to the object except for the RV, which is relative to the FS.

B.3.2 Post-Deployment Pointing

The FS shall maintain attitude control until reentry. It shall be capable of performing the maneuvers listed in Table B-3.

Table B-3. Post Deployment Pointing

Start Time (sec)	End Time (sec)	Attitude	Pointing Accuracy (deg)
1700	1794	Point FS at POI	± 5.0
1794 + maneuver	Reentry	Point antenna at RTS ground station	± 10.0